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DESCRIPTION

MOLDED ARTICLE

Technical Field:
The present invention relates to a molded article mainly made of pulp.

Background Art:
Plastics are used as general materials of hollow containers, such as containers with a lid and bottles, for their excellent molding properties and productivity. However, because plastic hollow containers involve various problems associated with waste disposal, hollow containers made of pulp have been attracting attention as substitutes for plastic containers. Pulp-made hollow containers are not only easy to dispose of but economical because they can be manufactured from used paper.

One of known methods for producing pulp-made hollow containers comprises making vertically split halves 7, 7' by pulp molding as shown in Fig. 20(a) and joining the two split parts together as shown in Fig. 20(b) to obtain a hollow container having the cross section of Fig. 20(c). According to this method, thickness at the joint of the spit parts should be made larger than the other portions, or margins for joining should be prepared beforehand at the production of the split halves, so as to secure strength of the joints. However, it is not easy to make only part of split parts thicker, and the operation for joining the split parts needs a lot of labor so that the productivity cannot be said to be high. Besides, the increased thickness at the joint can sometimes fail to secure sufficient strength, causing a leak of the contents, unless the joining is carried out sufficiently. Additionally, seams appear on the joints to impair the appearance.

Japanese Patent Application Laid-Open Nos. 133972/79 and 302600/96 propose methods for producing pulp-made hollow containers, but the methods are not adequate for solving the above-described problems perfectly.

Accordingly, an object of the present invention is to provide a pulp molded article having high strength, excellent productivity, and satisfactory appearance.

Disclosure of the Invention:

The present invention has achieved the above object by providing a molded article comprising pulp and having an opening portion, a body portion, and a bottom portion, wherein the body portion has no seams, the outer and inner surfaces of the article are smooth, and the body portion has at least one cross-sectional diameter which is greater than a corresponding cross-sectional diameter of the opening portion, the corresponding cross-sectional diameter of the opening portion being located within the vertical plane which contains the cross-sectional diameter of the body portion

In the present invention the term "cross-sectional diameter of the body portion" primarily denotes the length of a line across a cross section of the body portion, wherein the line passes through the center of the cross section. The "line" as referred to above does not always pass through the center of the cross section. The term "cross-sectional diameter of the opening portion" primarily means the length of a line across a cross section of the opening portion, wherein the line passes through the center of the cross section. The "line" as referred to above does not always pass through the center of the cross section.

Brief Description of the Drawings:

Fig. 1 is a perspective view showing a first embodiment of the molded article according to the present invention.

Fig. 2 is a vertical-sectional view of the molded article shown in Fig. 1.

Fig. 3 is a cross-sectional view of the molded article shown in Fig. 1.

Fig. 4 is an example of a fiber length frequency distribution of pulp fibers preferably used in the molded article of the present invention.

Fig. 5(a), Fig. 5(b), Fig. 5(c), and Fig. 5(d) show in sequence the steps for producing the molded article of the first embodiment.

Fig. 6 is a perspective view showing a second embodiment of the molded article according to the present invention.

Fig. 7 is a perspective exploded view of a mold which is preferably used in the production

of the molded article of the second embodiment.

Fig. 8 is a vertical-sectional view of the mold shown in Fig. 7, the view seen from the parting surface of the mold.

Fig. 9(a) and Fig. 9(b) show a part of the step of papermaking, one of the steps for producing the molded article according to the embodiment shown in Fig. 6.

Fig. 10 is a vertical-sectional view of a third embodiment of the molded article according to the present invention.

Fig. 11 is a cross-sectional view of the body portion of the molded article shown in Fig. 10.

Fig. 12 is a vertical-sectional view of a fourth embodiment of the molded article according to the present invention (corresponding to Fig. 2).

Fig. 13(a), Fig. 13(b), Fig. 13(c), and Fig. 13(d) show in sequence the step of laminating the inner wall of a molded article with a plastic film.

Fig. 14 is a partial perspective view with a cutaway portion of the essential part of a molded article having the outer surface thereof covered with a shrink film.

Fig. 15(a) and Fig. 15(b) illustrate the step of covering the outer surface of a molded article with a shrink film.

Fig. 16 is a vertical-sectional view of a fifth embodiment of the molded article according to the present invention (corresponding to Fig. 2).

Fig. 17(a), Fig. 17(b), and Fig. 17(c) show part of the step of papermaking, one of the steps for producing a multilayered molded article according to a sixth embodiment.

Fig. 18 schematically shows a multilayer structure of the multilayered molded article according to the sixth embodiment.

Fig. 19 schematically shows another multilayer structure of the multilayered molded article according to the sixth embodiment (corresponding to Fig. 18).

Fig. 20(a), Fig. 20(b), and Fig. 20(c) depict a conventional method for producing a pulp-made molded article.

Best Mode for Carrying out the Invention:

Preferred embodiments of the present invention will be illustrated with reference to the accompanying drawings.

Fig. 1 shows a molded article 10 according to the first embodiment, which is a cylindrical

bottle made mainly of pulp and composed of an opening portion 11, a body portion 12, and a bottom portion 13. The body portion 12 has a part thereof narrowed. The diameter of the narrow part is the smallest in the body portion 12 and is greater than that of the opening portion 11. That is, all the cross-sectional diameters of the body portion 12 of the molded article 10 of this embodiment are greater than corresponding cross-sectional diameters of the opening portion 11 located within the vertical plane which contains each of the cross-sectional diameters of the body portion. In the present embodiment, the smallest diameter in the body portion 12 is 20 to 100 mm, particularly 40 to 80 mm, and the diameter of the opening portion 11 is 10 to 50 mm, particularly 15 to 35 mm.

As shown in Figs. 2 and 3, the molded article 10 has a uniform wall thickness in each of its vertical section and cross section. In particular, unlike a conventional pulp molded article made by joining two split parts (see Fig. 20(c)), the molded article 10 of the present embodiment has no thicker-walled part by the joint of the split parts as depicted in Fig. 3. Accordingly, there is no joint seams by the joint of the split parts in the body portion 12 and over the portion from the body portion 12 to the bottom portion 13 as shown in Fig. 1. There is thus provided a container with enhanced strength and satisfactory outer appearance.

As shown in Fig. 2, the molded article 10 has a screw thread mating a cap around the outer wall of the opening portion 11. The vertical-sectional contour of the screw thread is trapezoidal. The vertical-sectional contour of the screw thread is not limited to a trapezoid and can be a triangle or a rectangle in accordance with the strength of the opening portion 11 or the productivity of the molded article 10 (e.g., easiness with which the screw thread is dried or easiness with which the shape is transferred). Where the molded article is to be capped and uncapped frequently, the screw thread preferably has a trapezoidal contour.

The molded article 10 has smooth outer and inner surfaces. In case where a plastic layer is formed on the outer and/or the inner surfaces as hereinafter described, the surface smoothness will secure satisfactory adhesion between the surface(s) and the plastic layer. Further, the surface smoothness would facilitate neat printing on the outer surface and

also provides better outer appearance. The terminology "smooth" as used herein means that the surface profile of the outer and inner surfaces of a container is such that the center-line average roughness (Ra, JIS B0601) is 50 μm or less, and the maximum height (Rmax JIS B 0601) is 500 μm or less.

As shown in Figs. 1 and 2, the molded article 10 has right angles between the body portion 12 and the bottom portion 13. That is, the tapering angle of the body portion 12 is 0°. The total height of the molded article 10 is 50 mm or more, preferably 100 mm or more.

The molded article 10 is made mainly of pulp. It can be 100% pulp-made. Where other materials are used in addition to pulp, the amount of the other materials is 1 to 70% by weight, preferably 5 to 50% by weight. The other materials include inorganic substances, such as talc and kaolinite, inorganic fibers, such as glass fiber and carbon fiber, synthetic resin powders or fibers, such as polyolefins, non-wood or plant fibers, and polysaccharides.

It is particularly desirable that the molded article 10 be made from a slurry, i.e., a paper stock, containing pulp fiber having an average fiber length of 0.8 to 2.0 mm, a Canadian Standard Freeness of 100 to 600 cc, and such a frequency distribution of fiber length as comprises 20 to 90%, based on the total fiber, of fibers whose length ranges from 0.4 mm to 1.4 mm and 5 to 50%, based on the total fiber, of fibers whose length is longer than 1.4 mm and not longer than 3.0 mm from the standpoint that cracks will not develop during papermaking to provide pulp molded articles excellent in surface smoothness.

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In more detail, it is preferred for the pulp fibers to have an average length of 0.8 to 2.0 mm, particularly 0.9 to 1.8 mm, especially 1.0 to 1.5 mm. If the average fiber length is less than 0.8 mm, cracks tend to develop on the surface of the molded article during papermaking or drying, or the molded article tends to have poor mechanical properties such as impact strength. If the average fiber length exceeds 2.0 mm, the pulp deposited body formed by papermaking tends to have unevenness of thickness only to provide a molded article with poor surface smoothness. The term "average fiber length" as used herein is a value obtained by measuring a frequency distribution of pulp fiber length and calculating an arithmetic mean from the distribution.

It is preferred for the pulp fiber to have a freeness of 100 to 600 cc, particularly 200 to 500 cc, especially 300 to 400 cc. A freeness less than 100 cc is so low that speed-up of the molding cycle tends to be difficult, and dewatering of the molded article tends to be insufficient. A freeness exceeding 600 cc is so high that the pulp deposited body formed by papermaking tends to suffer from unevenness of thickness.

It is preferred for the pulp fiber to have such a fiber length frequency distribution as comprises 20 to 90%, based on the total fiber, of fibers whose length is within a range of from 0.4 mm to 1.4 mm (hereinafter referred to as range A) and 5 to 50%, based on the total fiber, of fibers whose length is longer than 1.4 mm and not longer than 3.0 mm (hereinafter referred to as range B). Fig. 4 furnishes an example of fiber length frequency distribution curves of pulp fibers preferably used in the molded article of the present invention. The ratio of the area in range A (indicated with slant lines) to the total area in the frequency distribution curve is equivalent to the proportion (%) of the pulp fibers whose length falls within range A. Similarly, the ratio of the area in range B (indicated with slant lines) to the total area in the frequency distribution curve is equivalent to the proportion (%) of the pulp fibers whose length falls within range B. By using pulp fibers having such a frequency distribution as well as an average fiber length and a freeness falling within the above respective ranges, pulp molded articles uniform in thickness, free from crack development during papermaking, and excellent in surface smoothness can be obtained. It is still preferred that the proportion of the pulp fibers having a fiber length within range A be 30 to 80%, particularly 35 to 65% and that the proportion of the pulp fibers having a fiber length within range B be 7.5 to 40%, particularly 10 to 35%.

To further enhance the above-described effects, it is particularly preferred for the pulp fiber to have such a frequency distribution as has peaks P_A and P_B in ranges A and B, respectively, as represented by Fig. 4.

Pulp fibers having the aforesaid average fiber length, freeness and fiber length frequency distribution can be obtained by selecting, for example, the kind of the fiber (from, e.g., NBKP, LBKP, used paper pulp, etc.), beating conditions, conditions of blending two or more kinds of pulp, and the like. It is particularly preferred to prepare the above-

described pulp fiber by blending relatively long pulp fibers having an average fiber length of 1.5 to 3.0 mm and relatively short pulp fibers having an average fiber length of 0.3 to 1.0 mm at a ratio (the former/the latter) of 90/10 to 40/60 (by weight) for obtaining a molded article having high surface smoothness.

The molded article 10 preferably has a density (i.e., the density of the wall of the container) of 0.4 to 2.0 g/cm^3 to have suitable rigidity satisfying mechanical properties such as tensile strength and compressive strength. Still preferably the density is 0.6 to 1.5 g/cm^3 to secure an excellent feel on use. A particularly preferred density is 0.8 to 1.5 g/cm^3. With the density falling in the above range, the molded article 10 has a reduced void to inhibit penetration of liquid thereby exhibiting improved water resistance and barrier properties. Further, the molded article 10 has improved appearance making a good impression, improved surface properties, such as resistance to pulp fiber fluffing, and improved surface smoothness and surface hardness.

The molded article 10 which has a moisture permeability of 100 g/(m^2·24 hrs) or less, preferably 60 g/(m^2·24 hrs) or less, as measured in accordance with JIS Z 0208, absorbs little moisture in the air and thereby retains moderate rigidity and protects the quality of the contents from deterioration due to water absorption.

It is preferred for the molded article 10 to have a surface tension of 10 dyn/cm or less and water repellency (JIS P 8137) of R10. The molded article having such a surface tension and a water repellency can be obtained by molding a paper stock comprising the pulp slurry into which additives such as a waterproofing agent and a water repellant have been incorporated.

The molded article 10 which has a tensile strength of 5 MPa or more, particularly 10 MPa or more, is preferred for inhibiting rupture due to shocks, etc. The term "tensile strength" as used herein means a breaking strength measured in accordance with JIS P8113 in such a manner that a 15 mm wide by 140 mm long specimen cut out of an arbitrary portion of the molded article 10 is set on a tensile tester at a chuck distance of 100 mm and pulled at a pulling speed of 20 mm/min. In case where a molded article cannot afford a specimen of

the above size, the size of a specimen to be measured can be changed appropriately.

The molded article 10 which has a specific compressive strength of 100 Nm^2/g or more, particularly 110 Nm^2/g or more, is preferred, for it hardly collapses when stacked up on top of another. The term "specific compressive strength" as used herein is one measured in accordance with JIS P 8126.

It is preferred for the molded article 10 to have such a drop strength that it does not suffer damage including a break and a crack even when dropped 10 times in the drop test specified in JIS Z 0217. The opening portion of the molded article 10 preferably exhibits such strength that the force required for pressing the opening portion 11 from its side to give a deformation of 30 mm is 10 N or greater.

A preferred method for producing the molded article of the present embodiment will be described with reference to Fig. 5. The molded article of the present embodiment is produced by pulp molding, particularly conveniently by depositing pulp on the inner wall of a mold having a cavity. The steps for producing the molded article by this method are illustrated in sequence in Figs. 5(a) through (d), in which (a) is the step of papermaking, (b) is the step of inserting a pressing member, (c) is the step of pressurizing and dewatering, and (d) is the step of opening a split mold to take out a pulp deposited body.

As shown in Fig. 5(a), a pulp slurry is poured into a split mold composed of a pair of splits 3 and 4 each having a plurality of interconnecting holes 2 which connect the outer side thereof and the cavity 1. The pulp slurry is a water dispersion of pulp fiber and, if necessary, other components. The cavity configuration of the splits 3 and 4 is such that the resulting molded article may have a smaller diameter in the opening portion than in the body portion.

As shown in Fig. 5(a), the splits 3, 4 are evacuated from the outside to deposit the pulp fiber on the inner wall of the splits. As a result, a pulp deposited body 5 is built up on the inner wall of the splits.

As shown in Fig. 5(b), a hollow stretchable pressing member 6 having elasticity is inserted into the splits 3, 4 while evacuating the splits 3, 4. The pressing member 6 is to be inflated in the cavity like a balloon to press the pulp deposited body 5 onto the inner wall of the splits thereby transferring the inner configuration of the splits. Therefore, the pressing member 6 is made of urethane, fluorine rubber, silicone rubber, elastomers, etc., which are excellent in tensile strength, impact elasticity, stretchability, and the like.

Sequentially, as shown in Fig. 5(c), a pressurizing fluid is fed into the pressing member 6 to inflate it. The inflated pressing member 6 presses the pulp deposited body 5 onto the inner wall of the splits. While the pulp deposited body 5 is pressed onto the inner wall of the splits by the inflated pressing member, the configuration of the inner wall of the splits are transferred thereto. Since the pulp deposited body 5 is pressed from the cavity 1 side to the inner wall of the splits in this manner, the inner configuration of the split mold can be transferred to the pulp deposited body 5 with good precision however complicated the configuration may be. The above-described pressurizing fluid includes compressed air (heated air), oil (heated oil) and other liquids. The pressure for feeding the pressurizing fluid is 0.01 to 5 MPa, particularly 0.1 to 3 MPa.

After the configuration of the inner wall of the cavity 1 is sufficiently transferred to the pulp deposited body 5, and the pulp deposited body 5 is dewatered to a prescribed water content, the pressurizing fluid is withdrawn from the pressing member 6, whereupon the pressing member 6 shrinks automatically to its original size as shown in Fig. 5(d). The shrunken pressing member 6 is withdrawn from the cavity 1, and the splits 3, 4 are opened to take out the wet pulp deposited body 5 having the prescribed water content.

The pulp deposited body 5 thus taken out is then subjected to the step of heat drying. In the step of heat drying, the same operation as in the papermaking step shown in Fig. 5 is conducted, except that papermaking and dewatering are not carried out. That is, a mold, which is composed of a set of splits butted together to form a cavity in conformity to the outer contour of an article to be molded, is heated to a prescribed temperature, and the wet pulp deposited body is fitted into the mold.

Then, a pressing member similar to the pressing member 6 used in the papermaking step is put into the pulp deposited body, and a pressurizing fluid is fed into the pressing member to inflate it, whereby the pulp deposited body is pressed onto the inner wall of the cavity by the inflated pressing member. The material of the pressing member and the pressure for feeding the pressurizing fluid can be the same as those used in the papermaking step. In this state, the pulp deposited body is dried by heat. After the pulp deposited body dries thoroughly, the pressurizing fluid is withdrawn from the pressing member to shrink and take out the pressing member. The splits are opened to take out the molded article.

The molded article 10 thus produced is a cylindrical bottle of which the body portion 12 has a greater diameter than the opening portion 11. The opening portion 11, the body portion 12 and the bottom portion 13 each have no joint seams, and these portions 11, 12 and 13 are integrally formed with no joint seams. Both the outer and the inner surfaces of the molded article 10 are smooth.

The second to sixth embodiments of the molded article according to the present invention will be explained with reference to Figs. 6 to 19. Only the particulars different from the first embodiment will be described. The description about the first embodiment appropriately applies to the particulars that are not explained here. The members in Figs. 6 to 19 which are the same as those in Figs. 1 to 5 are given the same numerical references as used in Figs. 1 to 5.

The molded article 10 of the second embodiment shown in Fig. 6 is a cylindrical bottle having a narrowed portion in its body portion 12. The opening portion 11 has, in the area from the top edge 16 thereof to a prescribed depth d, a thick-walled portion 17 which is thicker than the body portion 12 and the bottom portion 13. The thick-walled portion 17 is continuous along the whole circumference of the opening portion 11. For some uses of the molded article 10, the thick-walled portion 17 may be discontinuous.

The thick-walled portion 17 can be formed over the whole area of the opening portion 11 from the top edge 16 in the depth direction of the opening portion 11, but the area from the top edge 16 to the prescribed depth d shown in Fig. 6 is sufficient as long as sufficient

mechanical strength is secured. A sufficient depth d is usually 0.5 to 50 mm, preferably 5.0 to 30 mm, while dependent on the use, the shape and the like of the molded article.

As shown in Fig. 6, the thick-walled portion 17 projects to the inward side of the molded article 10. The degree of projection, represented by the width x of the projection (see Fig. 6) from the inner wall of the portion having no thick-walled portion 17 in the opening portion 11 in the horizontal direction, is 0.5 to 5.0 mm, preferably 1.0 to 3.0 mm, which suffices to secure the mechanical strength of the opening portion 11. In addition, the top edge 16 of the opening portion 11 can have an increased area and offer an increased sealing surface area, which enhances the adhesive strength to sealing paper, etc. when it is sealed.

The opening portion 11 secures sufficient mechanical strength with the depth d and the width x of the projection being such that d/x is from 0.1 to 100, preferably 1 to 30. The part of the opening portion 11 that is deeper than the depth d may be tapered with the width x of the projection gradually decreasing thereby sloping the inner wall of the opening portion 11 as shown in Fig. 6.

It is preferred for the top edge 16 of the opening portion 11 to have a smooth surface to secure improved sealability where it is sealed with sealing paper, etc. The top edge 16 secures sufficient sealability with such smoothness as to have a center-line average roughness (Ra) of about 50 μm or smaller and a maximum height (Rmax) of about 500 μm or smaller. The top edge 16 can be made smooth by, for example, a post treatment such as polishing by a prescribed means after the production of the molded article 10. Preferably, a sufficiently smooth top edge 16 can be obtained without the above-described post treatment by producing the molded article by the use of the papermaking mold hereinafter described.

A preferred method for producing the molded article according to this embodiment will be described by referring to Figs. 7 through 9.

The molded article 10 of the present embodiment is preferably produced by use of a papermaking mold which comprises:

a set of splits, each having a plurality of interconnecting holes connecting the outside and the inside, which are butted to each other to form a cavity in conformity to the outer contour of an article to be molded and

a mold for creating a stagnant space which is to be inserted from the outside into the above-described cavity to form a space where a slurry stagnates between the inner wall of the cavity and the mold.

Fig. 7 shows a perspective exploded view of the mold used to produce the molded article of the present embodiment. The mold comprises a set of splits 3 and 4 having the same structure as the splits 3 and 4 shown in Fig. 5, except that the cavity configuration is different, and a mold 27 for causing stagnation (hereinafter "stagnation-causing mold") to be inserted from the outside into the cavity to form a space, where a slurry stagnates, between the inner wall of the cavity and the stagnation-creating mold. While not shown in Fig. 7, the inner wall of the split 4 has the same structure as that of the other split 3.

As shown in Figs. 7 and 8, the split 3 is composed of a papermaking part 21A and a manifold part 21B. The papermaking part 21A is fitted into the manifold part 21B to make up the split 3. With this fitting, a manifold 21C is formed between the papermaking part 21A and the manifold part 21B. The inner side of the papermaking part 21A may be covered with a net of prescribed size of mesh. A plurality of interconnecting holes 24, 24, ... are regularly pierced through the papermaking part 21A from the inner to the outer surfaces. These interconnecting holes 24 connect with the manifold 21C. A plurality of suction holes 21D are also pierced in both sides of the manifold part 21B thereby to form interconnecting passageways in the split 3 which connect the outside of the manifold part 21B and the inner surface of the papermaking part 21A.

On butting the splits 3 and 4 to each other as shown in Fig. 8, a cavity 1 is formed in the inner side thereof in conformity to the contour of an article to be molded. The part of the cavity 1 that corresponds to the opening portion 11 of the molded article (hereinafter referred to as a cavity part corresponding to an opening portion) has an opening open to the outside. Into this part is inserted a wall 27B for making the slurry stagnant (hereinafter "a slurry stagnation wall", described later) of the stagnation-causing mold 27.

While not depicted, the inner side of the cavity part corresponding to the opening portion has grooves having a configuration corresponding to a screw thread.

As shown in Figs. 7 and 8, the stagnation-causing mold 27 is composed of a rectangular top plate 27A and a cylindrical slurry stagnation wall 27B hanging from approximately the center portion of the lower side of the top plate 27A. The inner side of the slurry stagnation wall 27B forms a hollow cylinder which vertically pierces the stagnation-causing mold 27 and which serves as a gate 27C through which a slurry is poured into the mold. The slurry stagnation wall 27B of the stagnation-causing mold 27 is inserted into the cavity part corresponding to the opening portion, and the lower side of the top plate 27A and the upper end of the split mold 3, 4 are brought into contact to complete the mold.

The diameter of the slurry stagnation wall 27B is smaller than that of the cavity part corresponding to the opening portion. Therefore, with the slurry stagnation wall 27B inserted into the cavity part corresponding to the opening portion, an annular space 28 in which a slurry stagnates is formed between the inner wall of that part of the cavity and the outer side of the slurry stagnation wall 27B.

Figs. 9(a) and (b) illustrate a part of the papermaking step, one of the steps for producing the molded article 10 by use of the above-described mold, wherein (a) is the papermaking step, and (b) is the step of opening the mold and taking out a pulp deposited body. In Figs. 9, part of the mold is omitted from the illustration for the sake of simplicity.

As shown in Fig. 9(a), an injection pump (not shown) is started to suck up a pulp slurry from a pulp slurry storage tank (not shown) and inject the pulp slurry under pressure into the mold through the slurry gate 27C. Then, the cavity 1 is evacuated by suction from the outside of the splits 3 and 4, thereby to suck up the water content of the pulp slurry and to build up pulp fibers on the inner wall of the cavity 1. The pulp slurry goes around to fill the annular space 28 formed between the outer side of the slurry stagnation wall 27B and the inner side of the cavity part corresponding to the opening portion and easily stays there, making more amount of the pulp fibers accumulate there than on the other parts of the inner side of the cavity 1. Since the pulp slurry is injected into the cavity 1 under pressure,

the pulp slurry pressure is equal in every part of the cavity 1 so that the annular space 28 can sufficiently be filled with the pulp slurry. It follows that the pulp deposited body 5 formed on the inner wall of the cavity 1 has a thicker wall in the portion corresponding to the vicinities of the top edge of the opening portion of the resulting molded article than in the other portions. The thickness of the thicker portion corresponds to the breadth of the annular space 28.

Then, the same steps as the step of inserting a pressing member and the step of pressing and dewatering shown in Figs. 5(b) and (c) are carried out. As shown in Fig. 6, the resulting molded article 10 can have sufficiently enhanced strength in its thick-walled portion 17 near the top edge 16 of the opening portion 11 particularly through the pressing and dewatering step.

After the shape of the inner wall of the cavity 1 is sufficiently transferred to the pulp deposited body 5, and the pulp deposited body 5 is dewatered to a prescribed water content, the pressurizing fluid in the pressing member 6 is withdrawn, and the pressing member 6 is taken out from the cavity 1 as shown in Fig. 9(b). The mold is opened, and the pulp deposited body 5 in a wet state with a prescribed water content is taken out. Thereafter, the pulp deposited body 5 is forwarded to the step of heat drying in the same manner as in the process for producing the molded article of the first embodiment to obtain the molded article 10.

As stated above, the molded article 10 thus produced has a thick-walled portion 17 in the opening portion 11 from the top edge 16 to the prescribed depth d, which is thicker than the body portion 12 and the bottom portion 13. Further, the top edge 16 has a smooth surface without being given any special post treatment so that it exhibits sufficient adhesive strength when sealed with sealing paper, etc.

The thick-walled portion 17 in the molded article 10 of the present embodiment may project both inward and outward. The part of the thick-walled portion projecting outward can serve as, for example, a projection for fitting a cap used as needed.

Fig. 10 is a vertical-sectional view of the molded article according to the third embodiment

of the present invention. The molded article 10 of this embodiment is a carton box having an opening portion 11 in the upper portion thereof.

The body portion 12 and the bottom portion 13 connect via a curved portion 12' to give the molded article 10 increased impact strength. The radius of curvature of the curved portion 12' is preferably 0.5 mm or more, particularly 5 mm or more, especially 7 mm or more, from the standpoint of improvements on impact strength, drying efficiency, surface finish of the molded article, and adhesion to a plastic film used in the fourth embodiment hereinafter described. As shown in Fig. 11, the cross section of the molded article 10 is a rectangle with its four corners rounded to give the molded article 10 increased impact strength. The radius of curvature of the four corners is preferably 0.5 mm or more, particularly 5 mm or more, especially 7 mm or more, for the same reasons as described as for the curved portion 12'. The four sides of the rectangle are gently curved slightly outward. The body portion 12 has a continuous recess 29 around its circumference to make the molded body 10 easy to hold.

In the molded article 10, the angle θ between the plane of contact B of the bottom portion 13 and the outer surface of every side wall of the body portion 12 is more than 85°, preferably 89° or more (about 90° in Fig. 10) in any wall of the front and rear side walls and the left and right walls, and the height h (see Fig. 10) of the body portion 12 is 50 mm or more, preferably 100 mm or more. The angle θ can exceed 90°.

It is preferred for the molded article 10 of the present embodiment to have a larger thickness at the corners in its vertical section and/or cross section than the other portions to improve the compressive strength (buckling strength) of the molded article 10 as a whole over the one having equal thickness in every portion. For example, in the vertical-sectional view of the molded article 10 shown in Fig. 10, the thickness T2 of the corners, i.e., curved portions 12', is preferably greater than the thickness T1 of the body portion 12 (i.e., T2>T1). In this case, where T2/T1 is 1.5 to 2, the improvement on compressive strength of the whole molded article 10 can be secured. It is preferred that the thickness T1 be 0.1 mm or greater for the molded article 10 to exhibit the minimum compressive strength required. It is required for the molded article 10 to have a prescribed

compressive strength, considering that the molded articles 10 are to be transported or stacked up in a warehouse or a shop. Likewise, it is preferred that the molded article 10 has a larger thickness at the corners (T2) than in the other portions (thickness T1) also in its cross section at the body portion of the molded article 10 shown in Fig. 11.

In cases where the corners of the molded article 10 in the vertical section and/or the cross section satisfy the relationship that their density $\rho 2$ is smaller than the density ($\rho 1$) of the other portions (i.e., $\rho 1 > \rho 2$) as well as the above-described relationship between T1 and T2, there is produced an effect that two conflicting phenomena - an improvement in compressive strength of the molded article 10 and a reduction in amount of the material used - can result. This effect is more notable when $0.1 \times \rho 1 < \rho 2 < \rho 1$. The molded article 10 which satisfies these relationships has a compressive strength of 190 N or greater. The compressive strength as referred to here is the maximum strength in compressing the molded article 10 in the direction of height at a speed of 20 mm/min. The above-described relationships between T1 and T2 and between $\rho 1$ and $\rho 2$ can be established by, for instance, properly selecting the pressure or the amount of flow of the pressurizing fluid used in pressing with the pressing member 6, the material or shape of the pressing member 6, the shape of the molded article, and the like in carrying out the aforementioned preferred method for producing molded articles.

For example, molded articles 10 which were produced so as to have the T1, T2, $\rho 1$, and $\rho 2$ shown in Table 1 below in their cross section of the body portion (see Fig. 11) had the compressive strength shown in Table 1. It is seen that the compressive strength increases as the T2/T1 value increases and as the $\rho 2/\rho 1$ value decreases. Moreover, the example 2 having a higher compressive strength is lighter. The values T1, T2, $\rho 1$, and $\rho 2$ are the respective averages of values measured on four points of the body portion in the height direction.

TABLE 1

	T1 (mm)	T2 (mm)	T2/T1	ρ2/ρ1	Compressive Strength (N)	Weight (g)
Working Example 1	0.550	0.593	1.078	0.928	441	13.4
Working Example 2	0.595	0.835	1.403	0.713	500	13.0

The molded article 10 of the fourth embodiment which is shown in Fig. 12 has a thin plastic layer on its outer surface 14 and inner surface 15. Such plastic layers not only give the molded article 10 further increased strength but effectively prevent leaks of the contents. Because the outer surface 14 and the inner surface 15 of the molded article 10 are smooth, the plastic layers can be satisfactorily adhered to the outer surface 14 and the inner surface 15. While the thickness of each plastic layer is selected appropriately according to the wall thickness of the molded article 10, the kind of the contents and the like, it is usually 5 to 300 μm, particularly 10 to 200 μm, especially 20 to 100 μm. The two plastic layers may be the same or different in thickness. The materials constituting each plastic layer include various thermoplastic synthetic resins such as polyethylene and polypropylene, emulsion latices such as an acrylic emulsion, and waxes such as a hydrocarbon wax.

Where, in particular, a plastic layer is formed by laminating with a plastic film, an appropriate material is selected according to the purpose of laminating, for example imparting water resistance or gas barrier properties. For instance, a film of a polyolefin, e.g., polypropylene or polyethylene, a polyester, e.g., polyethylene terephthalate or polybutylene terephthalate, polystyrene, polycarbonate, etc. can be used. A multilayer film composed of a plurality of films made of these materials can also be used.

A plastic layer can be formed on the inner surface of the molded article 10 by, for example, replacing the pressing member 6 having elasticity used in the method of producing a molded article shown in Fig. 5 with a pressing member of bag form made of a plastic film of polyethylene or polypropylene, etc., the plastic film having aluminum or silica deposited thereon, the plastic film laminated with aluminum foil, etc., and the like. After pressing

the pulp deposited body 5, such a pressing member of bag form is not taken out but superposed on the inner surface of the pulp deposited body 5 to thereby form a plastic layer on the inner surface of the molded article 10.

A plastic layer can also be formed on the inner surface of the molded article 10 by replacing the elastic pressing member with a plastic closed-end cold parison (preformed parison) having been preheated to a predetermined temperature. The parison is inserted into the pulp deposited body 5, and a pressurizing fluid is fed into the parison to inflate it. The plastic film is thus adhered to the inner surface of the pulp deposited body to thereby form a plastic layer on the inner surface of the molded article 10.

As an alternative for laminating the inner surface of the molded article 10 with a plastic film, vacuum forming or pressure forming is also useful. The method depicted in Fig. 13 is suitable. In this method a first vacuum chamber 30 and a second vacuum chamber 40 are used as shown in Fig. 13(a). The first vacuum chamber 30 has an opening 31 at the top and a through-hole 32 in the side wall near the bottom. The through-hole 32 is connected to a suction means not shown. The inner contour of the cross section of the opening 31 is made slightly larger than the outer contour of the cross section of the opening portion 11 of the molded article 10. On the other hand, the second vacuum chamber 40 has an opening 41 at the bottom. The opening 41 of the second vacuum chamber 40 is shaped to close the opening 31 of the first vacuum chamber 30. The inner contour of the cross section of the opening 41 is made larger than that of the opening 31 of the first vacuum chamber 30. The upper side surface of the second vacuum chamber 40 has a plurality of through-holes 42, 42 ..., which are connected to a suction means not shown. A heating means 43 such as an electric heater is provided on the inner wall of the upper side surface of the second vacuum chamber 40.

The inner surface of a hollow container 1 can be laminated with a plastic film by use of the vacuum chambers 30 and 40 as follows. As shown in Fig. 13(a), a molded article 10 is placed in the first vacuum chamber 30 with its opening portion 11 up. The depth of the first vacuum chamber 30 is virtually the same as the height of the molded article 10 so that the upper opening edge of the placed molded article 10 and that of the first vacuum

chamber 30 are located on almost the same plane.

In this state a stretchable plastic film 50 in its unstretched state is placed to close the opening 31. Larger than the cross section of the first vacuum chamber 30, the plastic film 50 closes the opening 31 and also covers all the upper edge surface of the opening 31. Subsequently, the second vacuum chamber 40 is set on the first vacuum chamber 30 with its opening 41 facing the plastic film 50. Since the first and the second vacuum chambers 30 and 40 are of the same shape in their cross sections, the plastic film 50 are held in between the periphery of the opening 31 of the first vacuum chamber 30 and the periphery of the opening 41 of the second vacuum chamber 40. Each inner side of the first and the second vacuum chambers 30 and 40 is thus made air-tight. To maintain sufficient air tightness in each vacuum chamber, the two vacuum chambers may be fastened together by a fixing means such as a metal fastener.

The inside of the second vacuum chamber 40 is then sucked by a suction means (not shown) connected to the through-holes 42, whereby the inside of the second vacuum chamber is evacuated, and the plastic film 50 is drawn up in the second vacuum chamber 40 and stretched gradually. On continuing the suction of the inside of the second vacuum chamber 40, the plastic film 50 is further stretched and comes into close contact with the inner wall of the second vacuum chamber 40 as shown in Fig. 13(b). The stretching in this stage is preliminary. The stretch ratio is decided appropriately in accordance with the shape of the molded article 10 on which the plastic film 50 is superposed. In general, when the plastic film 50 is preliminarily stretched with the ratio of the surface area of the preliminarily stretched plastic film 50 to that of the plastic film superposed on the molded article 10 (the former/the latter) being 3 to 0.7, particularly 2 to 0.9, laminating the molded article 10 with the plastic film 50 can be accomplished with improved adhesion, and laminating the molded article 10 having a complicated shape is carried out more easily. The pressure (degree of vacuum) in the second vacuum chamber 40 is such that the plastic film 50 may be preliminarily stretched to come into intimate contact with the inner wall of the second vacuum chamber 40. While depending on the thickness and material of the plastic film 50, the pressure is generally 40 kPa or lower, preferably 1 to 1300 Pa.

While the preliminarily stretched plastic film 50 is in intimate contact with the inner wall of the second vacuum chamber 40, it is heated to a prescribed temperature by the heating means 43 provided on the inner wall of the upper side surface of the second vacuum chamber 40. The plastic film 50 is softened by this heating to further secure the intimate contact of the plastic film 50 with the molded article 10 in laminating and to further facilitate laminating the molded article 10 having a complicated shape. For example, in using polyethylene or polypropylene having a glass transition temperature (Tg) of room temperature (23°C) or lower as a constituent material of the plastic film 50, the heating temperature preferably ranges from (melting point + 30)°C to (melting point –70)°C, particularly from (melting point + 5)°C to (melting point – 30)°C. In using polyethylene terephthalate or polystyrene whose Tg is room temperature or higher as a constituent material, the heating temperature preferably ranges from (Tg + 5)°C to (Tg + 150)°C, particularly (Tg + 10)°C to (Tg + 100)°C. Within these ranges, plastic film 50 can be superposed with closer contact on the molded article 10 without tearing. Where the plastic film 50 is made of two or more kinds of materials, the glass transition temperature of the material having the lowest glass transition temperature is taken as the above-described glass transition temperature.

While the plastic film 50 being in close contact with the inner wall of the second vacuum chamber 40 by suction, the inside of the first vacuum chamber 30 is sucked by a suction means (not shown) connected to the through-hole 32. Since there is a gap between the inner wall of the opening 31 of the first vacuum chamber 30 and the outer wall of the opening portion 11 of the molded article 10, the inside and the outside of the molded article 10 interconnect with each other to let gas flow therethrough. Therefore, the above evacuation by suction creates a vacuum inside the first vacuum chamber 30, i.e., the inside and the outside of the molded article 10 similarly to the inside of the second vacuum chamber 40. In this state, the plastic film 50, which has been in intimate contact with the inner wall of the second vacuum chamber 40, is not drawn into the first vacuum chamber 30 by the evacuation of the inside of the first vacuum chamber 30. While not particularly limited, a pressure (degree of vacuum) of the inside of the first vacuum chamber 30 is preferably 40 kPa or lower, particularly 1 to 1300 Pa as a general range.

Then, the evacuation by suction of the second vacuum chamber 40 is stopped. Further, the vacuum in the second vacuum chamber 40 is broken and, at the same time, pressure is applied into the second vacuum chamber 40 to a predetermined pressure. These operations can be performed instantaneously by switching a three-way valve, etc. Because the first vacuum chamber 30 is in the evacuated state, the plastic film 50 which has been in intimate contact with the inner wall of the second vacuum chamber 40 is instantaneously drawn and stretched toward the inside of the first vacuum chamber 30, i.e., the inside of the molded article 10 in the present embodiment, whereby the inner surface of the molded article 10 is laminated with the plastic film 50 with intimate adhesion as shown in Fig. 13(c). In other words, the plastic film 50 is stretched in the direction opposite to the direction of preliminary stretching. Having been heated to a predetermined temperature by the heating means 43 until the vacuum of the second vacuum chamber 40 is broken, the plastic film 50 can be stretched and intimately adhered to the molded article 10 extremely smoothly, whereby the plastic film 50 can effectively be prevented from tearing or the like on stretching. Pressure application into the second vacuum chamber 40 is carried out with a prescribed pressurizing fluid, conveniently air. In order for the plastic film 50 to be brought into intimate contact with the molded article 10 without tearing, the pressure to be applied is preferably 100 to 3000 Pa, particularly 200 to 1000 Pa.

Where superposing the plastic film 50 on the molded article 10 is conducted with the molded article 10 being heated to a predetermined temperature, the plastic film 50 can be superposed on the molded article 10 with further improved adhesion while being prevented from tearing more effectively. This is because satisfactory stretchability of the plastic film 50 is maintained during the superposing. The molded article 10 can be heated by, for example, a prescribed heating means provided on the inner side of the side wall of the first vacuum chamber 30. A preferred heating temperature of the molded article 10 is from 40 to 150°C for preventing re-shrinkage of the plastic film 50 and securing the production efficiency.

After the plastic film 50 is superposed, the evacuation by suction of the inside of the first vacuum chamber 30 is stopped, and the inner pressure of the first vacuum chamber 30 is increased to atmospheric pressure. The second vacuum chamber 40 is then removed, and

the molded article 10 laminated with the plastic film 50 is taken out of the first vacuum chamber 30. At this time, the unsuperposed plastic film 50 remains around the opening portion of the molded article 10, which is trimmed to give the molded article 10 shown in Fig. 13(d) which has the inner surface thereof and the upper edge of its opening portion covered and laminated with the plastic film 50 with intimate adhesion.

According to the above-mentioned method of production, the plastic film 50 can be superposed on the molded article 10 with good adhesion without tearing even if it is stretched at a stretch ratio as high as 4 to 10, where the stretch ratio of the plastic film 50 is defined as a ratio of the surface area of the plastic film 50 superposed on the molded article 10 and the opening area of the opening 31 of the first vacuum chamber 30 (the former/the latter).

The above method of production has a merit that the molded article 10 can be laminated with a film irrespective of whether or not it has air permeability. Further, because it is not necessary to evacuate through the wall of the molded article 10, the time required for evacuation by suction and emission can greatly be shortened as compared with conventional vacuum forming and the like to thereby markedly improve the productivity. Furthermore, the molded article 10 does not suffer from deformation by evacuation, it is not necessary to use a reinforcing mold as in conventional vacuum forming and the like, which leads to production cost reduction.

Where the above-described laminating method is adopted, it is preferred to use a stretchable film as the plastic film. In this case, it is preferred for the plastic film to have a thickness of about 5 to 200 μm, particularly about 20 to 100 μm, after laminating so as to impart desired characteristics such as water resistance and gas barrier properties to the molded article 10. The thickness before laminating, while varying depending on the thickness after laminating, the stretch ratio, etc., preferably ranges from about 50 to 1000 μm, particularly about 100 to 500 μm, from the viewpoint of handling properties during the production and the plastic film heating efficiency.

In carrying out laminating with the plastic film 50 shown in Fig. 13, the molded article 10 is

placed upside down (the opening portion 11 of the molded article 10 facing downward) in the first vacuum chamber 30, whereby the outer surface of the molded article 10 can be laminated with the plastic film 50. It is possible to laminate both the inner surface and the outer surface (except the bottom surface) of the molded article 10 with a single plastic film at the same time by making the opening 31 of the first vacuum chamber 30 extremely larger than the outer contour of the opening portion 11 of the molded article 10 to provide a wide gap between the opening 31 of the first vacuum chamber 30 and the opening portion 11 of the molded article 10. In this case, another film can be set between the bottom surface of the molded article 10 and the inner wall of the bottom of the first vacuum chamber 30 so that the inner and the outer surfaces, including the bottom surface, of the molded article 10 may be laminated with the two films simultaneously.

When the molded article having the inner and/or the outer surfaces thereof laminated with the plastic film by any of the above-described methods is left to stand at 60°C for 30 minutes, the plastic film preferably has a shrinkage percentage of 30% or less, particularly 10% or less.

If the shrinkage percentage exceeds 30%, there is a fear that the plastic film peels in parts and that tearing of the molded article 10 initiates from the parts where the plastic film peels. That is, long-term storage stability reduces. The shrinkage percentage is obtained from the distance between two arbitrary points on the plastic film-laminated surface of a molded article measured before and after the storage under the above-described conditions according to formula: (1 − distance before storage/distance after storage) × 100. The shrinkage percentage can be made 30% or less by, for example, heating the plastic film-laminated molded article to the glass transition point of the plastic film or a higher temperature, followed by gradual cooling. Where the plastic film is a laminate comprising two or more plastic materials, the heating is at or above the glass transition point of the plastic material having the lowest glass transition point.

There is another embodiment for forming a plastic layer on the outer and/or the inner surfaces of a molded article, which comprises powder coating the outer and/or the inner surfaces of the molded article to form a plastic layer(s).

If a solvent- or water-based paint is used for plastic layer formation, the plastic layer tends to form micropores while the solvent or the like evaporates, resulting in a fear of failure to manifest sufficient gas barrier properties (shielding against water or oxygen). There is also a fear that the solvent, etc. may deform the molded article. Contrarily, a plastic layer formed by powder coating is free from these disadvantages, providing a molded article with sufficient gas barrier properties.

Powder which can be used for powder coating includes powder of olefin resins, polyester resins, epoxy resins, acrylic resins, etc. The powder can consist solely of the resin or, if necessary, it can be colored by addition of various pigments. In addition, conventional additives known to be useful in paint compositions can be used with no particular restriction. Such additives include leveling agents, e.g., acrylate polymers and silicone resins, and pinhole preventing agents, e.g., benzoin. These additives are preferably added in an amount of about 0.1 to 5 parts by weight each per 100 parts by weight of the resin. The total thickness of the plastic layer(s) (the total of the plastic layers formed on the outer and the inner surfaces of a molded article) is decided appropriately according to the use of the molded article, the wall thickness, the kind of the contents and the like, and is usually from 50 to 600 μm. From the standpoint of moisture permeability, productivity, and cost, a preferred total thickness is 100 to 400 μm.

Powder coating can be carried out with a coating gun, which has at the tip thereof a nozzle equipped with a corona electrode for forcibly charging the powder simultaneously with ejecting the powder paint. The powder paint ejected and charged simultaneously is applied to the surface to be coated, i.e., the outer and/or the inner surfaces of the molded article by electrostatic force. To secure the application, it is preferred to apply a voltage of −10 to −80 kV, particularly −40 to −70 kV, to the powder paint.

Application of the powder paint is followed by a baking step in which the applied powder paint is melted and hardened to form a plastic layer. A baking oven capable of heating to a prescribed temperature is used for baking. From the standpoint of productivity, smoothness of the coating film, and prevention of scorching of the pulp, the baking is carried out at a temperature of 70 to 230°C, particularly 140 to 200°C, for a period of 1 to

20 minutes, particularly 5 to 20 minutes.

There is still another embodiment for forming a plastic layer on the outer and/or the inner surfaces of a molded article, which comprises applying a molten resin or a resin emulsion to the outer and/or the inner surfaces of a molded article to form a plastic layer. In this embodiment, the plastic layer preferably has a thickness of 5 to 300 μm, particularly 20 to 150 μm, and the ratio of the thickness of the plastic layer to the thickness of the molded article (the former/the latter) is preferably 1/2 to 1/100, particularly 1/5 to 1/50.

If the thickness of the plastic layer is smaller than 5 μm, the storage stability of the contents tends to be insufficient because of failure to produce sufficient waterproofness and moistureproofness. If the thickness exceeds 300 μm, the plastic layer needs time for drying, and the coating liquid tends to sag while applied, resulting in such defects as unevenness of thickness of the plastic layer. The thickness of the plastic layer can be measured by microscopic observation of the section of the molded article. The molded article according to this embodiment has a clear boundary between the pulp fiber constituting the molded article and the resin constituting the plastic layer unlike an article whose plastic layer is formed by coating a molded article made of pulp with a coating liquid in a conventional manner. That is, in a conventional method, an aqueous solution of a polymer penetrates into an undried molded article so that the boundary between the pulp fiber and the polymer is indefinite, whereas the molded article of the present embodiment is less pervious to the resin to make the boundary definite. As a result, the molded article can be made waterproof and moistureproof with a smaller amount of the resin than needed conventionally, and the pulp fiber can be disintegrated more easily when recycled.

If the thickness ratio of the plastic layer to the molded article exceeds 1/2, disintegrability in recycling is poor. If it is less than 1/100, sufficient waterproofness and moistureproofness cannot be obtained. The thickness of the molded article, which is appropriately decided according to the use, etc. so that the above ratio may fall within the range of from 1/2 to 1/100, is preferably from the range of 100 to 3000 μm, still preferably 500 to 2000 μm.

The resin used in the coating composition for forming a plastic layer includes acrylic resins,

styrene-acrylic resins, ethylene-vinyl acetate resins, styrene-butadiene rubber resins, polyvinyl alcohol resins, vinylidene chloride resins, waxes, fluorine resins, silicone resins, and copolymers and polyblends of these resins.

In order to control penetration of the coating liquid into the molded article, it is preferred for the molded article to have a void of 30 to 70%, particularly 40 to 60%. The void is calculated from the following formula (1). In formula (1), the density of a molded article is calculated from the weight and the thickness of a piece cut out of the molded article, and the density of the material constituting the molded article is calculated from the proportions and the density of pulp fiber and other components.

Void (%) = (1 − density of molded article/density of material constituting molded article) × 100 ... (1)

With too small the void, the molded article may be too impervious to the coating liquid, tending to have reduced adhesion to the plastic layer. Taking the penetrability of the coating liquid into consideration, it is preferred for the molded article to have a Cobb's water absorptiveness (JIS P 8140) of 5 to 600 g/(m^2·2 mins), particularly 10 to 200 g/(m^2·2 mins).

The coating composition is applied by spraying with a prescribed spraying means after the wet pulp deposited body 5 obtained in Fig. 5(d) is preliminarily dried to a prescribed water content, e.g., about 0.1 to 25% by weight. The void of the molded article being within the above range, the coating composition hardly penetrates into the molded article. As a result, most of the coating composition remains on the surface of the molded article, succeeding in manifesting sufficient waterproofness and moistureproofness with a smaller amount of the coating composition than conventionally required. In addition, reduction in disintegrability of the pulp fiber in recycling is avoided. In using an emulsion as a coating composition, it is desirable to use an emulsion having a resin particle size of about 0.01 to 10 μm for controlling penetration of the emulsion into the molded article.

Yet another embodiment for forming a plastic layer on the outer surface of the molded

article 10 comprises covering the outer surface of the molded article 10 with a shrink film with or without prescribed letters, figures, symbols, etc. printed thereon. The shrink film covers the entire outer surface of the molded article 10 so that penetration of water or oxygen from the outside into the inside can be prevented thereby to prevent reduction in paper strength of the molded article 10 and to prevent mold development in the contents. Further, reduction in quality of the contents due to penetration of water or oxygen can also be prevented. Furthermore, the strength of the molded article 10 is further enhanced, and the contents are effectively prevented from leaking.

According to the kind of the contents, the shrink film does not need to cover the entire outer surface of the molded article. The mode shown in Fig. 14 is especially effective in the case of such contents as to generate gas on moisture absorption and the like. The shrink film 51 covers not all the outer surface of the molded article 10 but the area of the outer surface of the molded article 10 up to the height of or above the upper level of contents 52 and below the top of the container (the space between the upper level of the contents 52 and the top of the container is called a head space). In case the contents react due to moisture absorption, etc. to generate gas, and the gas is accumulated in the head space, the gas has its escape blocked if the outer surface of the molded article 10 around the head space is covered with the shrink film 51. It follows that the molded article 10 is inflated and deformed, which makes the molded article instable and, in the worst case, ends up bursting. According to the wrapping mode shown in Fig. 14, such a phenomenon does not occur because the generated gas is allowed to escape outside through the wall of the molded article 10 around the head space.

The wrapping mode of Fig. 14 also has a merit that the use of the shrink film can be reduced. It may be conceivable that water or oxygen can enter through the wall of the molded article 10 around the head space. Even if it happens, the contact of water or oxygen with the contents is indirect as mediated by the head space. The space of this indirect contact of water or oxygen is far slower than that of the direct contact of water or oxygen with the contents through the wall of the molded article 10 in view of material transfer. Accordingly only if the molded article 10 is wrapped up to the height of the contents, i.e., only if the direct contact through the wall of the molded article 10 is avoided,

penetration of water or oxygen through the wall of the molded article 10 around the head space is not so problematical.

The shrink film 51 comprises a film of an olefin resin, a polyester resin, etc. For example, polyethylene terephthalate (PET), oriented polystyrene (OPS), etc. are useful as a material having good low-temperature shrinkability and high nerviness. For shrink packaging a product all over (overwrapping), polypropylene (PP), polyethylene (PE), etc. are useful as a thin and well-stretchable material. The above-described materials of shrink films comprise a uniaxially or biaxially stretched film having a single-layer or multilayer structure. Taking shrink finish, dimensional stability, and strength into consideration, it is desirable to choose a material having a heat shrinkage percentage (JIS Z1709) of 40% or more, a spontaneous shrinkage percentage (40%, 7 days) of 2% or less, a tensile strength of 20×10^6 Pa or more in the direction of shrinkage, and an elongation of 50% or more. The thickness of the shrink film 51, which is appropriately selected according to the use of the molded article 10 covered with the shrink film 51, the wall thickness of the molded article 10, the kind of the contents, and the like, is usually 10 to 150 μm, particularly 30 to 70 μm.

The molded article 10 having the outer surface thereof covered with the shrink film has an oxygen permeability of 500 $cm^3/(m^2 \cdot hr \cdot atm)$ or less, particularly 100 $cm^3/(m^2 \cdot hr \cdot atm)$ or less. It prevents the inside thereof from getting into a peroxidized state thereby to prevent reduction or deterioration of the quality of the contents. The oxygen permeability is measured according to the method specified in JIS K7126.

The molded article having the outer surface thereof covered with a shrink film is preferably produced by surrounding the molded article having a water content of 5 to 35% by weight by the shrink film and applying microwaves to shrink the shrink film into intimate contact with the molded article and, at the same time, to dry the molded article.

As shown in Fig. 15(a), the entire outer surface of the molded article 10 is surrounded by the shrink film 51. It is preferred to use the molded article 10 produced by the method of Fig. 5(d) which has a prescribed water content. The shrink film is prepared by making a sheet into a cylinder, and sealing one end of the cylinder in the form of an arch (generally

called R sealing) followed by a cut of the other end. In this state, the gap between the outer surface of body and the bottom portions of the molded article 10 and the shrink film is not so wide, while the gap between the outer surface of the opening portion and the shrink film is relatively wide.

As shown in Fig 15(b), an overcover 54 having a lid part 53 having a hanging down-wall over its periphery is put over the opening portion of the molded article 10 and the upper part of the shrink film that surrounds the opening portion. The whole lid part 53 including the down-wall is capable of generating heat on irradiation with microwaves. The gap between the inner side of the down-wall and the shrink film is preferably as small as possible.

In this state, microwaves are applied, whereupon the water content of the molded article 10 is heated to generate heat, and the shrink film shrinks to tightly adhere to the molded article 10 by the generated heat. At the same time, the water content is removed from the molded article 10 to finally dry the molded article. In other words, this method can achieve the two steps - shrinking of the shrink film 51 and final dry of the molded article 10 - in a single operation of microwaves application.

On being irradiated with microwaves, particularly in the area around the opening portion of the molded article 10, not only the molded article 10 but the lid part 53 of the overcover 54 generates heat, with which the shrink film shrinks to reduce the gap between the shrink film and the outer surface of the opening portion. Thus, the heat generated from the opening portion itself is added to the shrink film to accelerate the shrinkage of the shrink film. As a result, shrinkage around the opening portion that is not easy due to the diameter difference from the other portions can be achieved very easily. Additionally, the shrink film after shrinkage has improved appearance. Thus, shrinkage of the shrink film by the use of the overcover 54 is effective in case where the diameters of the molded article are different from its opening portion to the bottom portion. Where the opening portion has a smaller diameter than the body portion, it is particularly effective where the diameter of the opening portion is not more than 50% of that of the body portion.

As described above, the lid part 53 of the overcover 54 is capable of generating heat on microwaves application. The lid part 53 is preferably made of water-containing wood, paper, sponge or nonwoven fabric, etc., taking into consideration ease in shaping in conformity with the outer contour of a molded article, good heat generation efficiency, satisfactory properties of covering a shrink film, and satisfactory operating properties. The shape of the lid part 53 is not particularly limited as long as the shrink film around the opening portion of the molded article 10 can be surrounded thereby.

The wavelength of the microwaves applied is generally 300 MHz to 300 GHz. A wavelength providing the highest heat generation efficiency is selected appropriately.

The molded article 10 thus covered with the shrink film is then filled with the contents. Depending on the kind of the contents, the molded article 10 which is preliminarily dried may be filled with the contents, followed by covering with the shrink film.

The molded article 10 according to the fifth embodiment shown in Fig. 16 has the whole or a part of the opening portion 11 formed of plastic. Since it is the opening portion that receives the highest load in use of the molded article 10, use of plastic as a material forming this portion improves the durability of the molded article. The plastics to be used include those which can constitute the plastic layers in the fourth embodiment. Where a part of the opening portion is made of plastic, it is advantageous for improving the durability of the molded article to make a sealing part, such as a thread engaging part, an inner ring or a contact ring for a cap, and the like, of plastics.

The molded article according to the sixth embodiment has a multilayered structure comprising a first pulp layer, a second pulp layer different from the first pulp layer in composition, and a mixed layer located between the first pulp layer and the second pulp layer, the mixed layer having a continuous gradient in composition in which the composition changes from that of the first pulp layer to that of the second pulp layer.

The multilayered molded article according to this embodiment is preferably produced by; injecting under pressure a first pulp slurry into the cavity of a mold which comprises a set of

splits for papermaking butted to each other to form a cavity in conformity to the outer contour of an article to be molded, each split having a plurality of interconnecting holes connecting the outside and the inside,

dewatering the cavity to form a first pulp layer on the inner wall of the cavity while injecting under pressure a second pulp slurry different from the first pulp slurry in composition into the cavity, and

further dewatering the cavity to form a mixed layer on the first pulp layer, the composition of the mixed layer continuously changing from that of the first pulp layer to that of a second pulp layer, and further form a second pulp layer on the mixed layer.

In Fig. 17 is shown a part of the papermaking step out of the steps involved for producing the multilayered molded article according to the present embodiment, wherein (a) is the step of injecting a first pulp slurry, (b) is the step of dewatering the first pulp slurry and injecting a second pulp slurry, and (c) is the step of dewatering the second pulp slurry.

As shown in Fig. 17(a), a set of splits of a mold are butted to each other to form a cavity 1 therein in conformity to the outer contour of an article to be molded, and a predetermined amount of a first pulp slurry I is injected through the upper opening of the mold into the cavity 1 under pressure. The structures of the splits 3 and 4 are the same as the splits shown in Fig. 5. Pressure injection of the first pulp slurry I can be done by means of, e.g., a pump. The injection pressure of the first pulp slurry I is preferably 0.01 to 5 MPa, still preferably 0.01 to 3 MPa.

The cavity 1 being pressurized, the water of the first pulp slurry is discharged out of the mold, while the pulp fibers are accumulated on the inner wall of the cavity 1 to form a first pulp layer 55 as an outermost layer on the inner wall of the cavity 1 as shown in Fig. 17(b). A second pulp slurry II different from the first pulp slurry I in composition is then injected into the cavity 1 through the upper opening of the mold under pressure. As a result, there is a mixed slurry comprising the first pulp slurry and the second pulp slurry in the cavity 1. The injection pressure of the second pulp slurry II can be about the same as that of the first pulp slurry I.

While the second pulp slurry is injected under pressure, dewatering from the cavity 1 is continued to form a mixed pulp layer (not shown), which comprises the components of the mixed slurry, on the first pulp layer 55. Since the ratio of the second pulp slurry to the first pulp slurry in the mixed slurry increases continuously with time, the composition of the mixed layer formed on the first pulp layer 55 continuously changes from first pulp slurry-rich to second pulp slurry-rich compositions.

As the second pulp slurry II is injected under pressure while continuing pressurizing and dewatering by introducing air under pressure into the cavity 1 as shown in Fig. 17(c), the composition of the mixed slurry in the cavity 1 finally becomes equal to the composition of the second pulp slurry. Eventually, as shown in the Figure, a second pulp layer 57 comprising the component of the second pulp slurry is formed on the mixed layer as an innermost layer.

In the production method according to this embodiment, since injection of the first pulp slurry I and that of the second pulp slurry II into the cavity ~~18~~ 1 are continuous, a multilayered molded article can be produced efficiently.

The first and the second pulp slurries are not particularly limited in kind as long as they have different compositions.

After the second pulp layer 57 is formed to a prescribed thickness, the pressure injection of the second pulp slurry is ceased, and air is introduced into the cavity 1 under pressure for pressurizing and dewatering. The resulting pulp deposited body is subjected to the same steps as in the method of producing the molded article of the first embodiment, which includes the above-described steps shown in Figs. 5(b) through (d), to obtain a multilayered molded article.

The multilayered structure of the molded article according to the present embodiment is as shown in Fig. 18. Between the first pulp layer 55 as an outermost layer and the second pulp layer 57 as an innermost layer, there exists the mixed layer 56 whose composition continuously changes from that of the first pulp layer to that of the second pulp layer. As

a result, the adhesion strength between the first pulp layer 55 and the second pulp layer 57 is increased, and separation of these layers is prevented effectively. The existence of the mixed layer 56 between the first pulp layer 55 and the second pulp layer 57 can be confirmed by microscopic observation of the section of the molded article.

The thicknesses of the first pulp layer 55, the mixed layer 56 and the second pulp layer 57 are decided appropriately according to the use and the like of the molded article. Where, in particular, pulp fiber of low whiteness is used as an inner layer, it is preferred for the outermost layer (the first pulp layer 55 in this particular embodiment) to have a thickness of 5 to 50%, especially 10 to 50%, of the total thickness of the molded article so as to exhibit sufficient masking properties when seen from the outside. The thickness of each layer depends on the amounts and the concentrations of the first and second pulp slurries used in the production of the molded article.

Having a multilayered structure, the molded article of the present embodiment can have different functions served by the individual layers. For example, only the first pulp layer 55 as the outermost layer can be made a colored layer by incorporating a colorant, such as a pigment or a dye, or colored Japanese paper or a colored synthetic fiber into the first pulp slurry. In case where pulp having a relatively low whiteness, such as one obtained from used paper, e.g., de-inked pulp, is compounded into the first pulp slurry (e.g., to a whiteness of 60% or more, particularly 70% or more), incorporating the colorant only into the first pulp slurry is advantageous in that the color tone of that slurry can be adjusted with ease. The amount of the colorant to be added is preferably 0.1 to 15% by weight based on the pulp fiber.

Where a slurry comprising hard wood bleached pulp (LBKP) is used as the first pulp slurry, the resulting molded article has improved surface smoothness and suitability to printing or coating.

Incorporating additives, such as waterproofing agents, water repellents, water-vaporproofing agents, fixing agents, oilproofing agents, antifungal agents, antimicrobial agents, antistatic agents, and the like, into the first pulp slurry imparts the respective

functions to the first pulp layer 55 as the outermost layer. Further, incorporating a particulate or fibrous thermoplastic synthetic resin to the first pulp slurry imparts abrasion resistance to the first pulp layer 55 to suppress fluffing and the like. The degree of abrasion resistance is preferably 3H or more in terms of pencil hardness (JIS K 5400).

It is particularly preferred for the pulp slurry to be used for forming the first pulp layer 55 as the outermost layer to contain pulp fibers having an average fiber length of 0.2 to 1.0 mm, particularly 0.25 to 0.9 mm, especially 0.3 to 0.8 mm, a Canadian Standard Freeness of 50 to 600 cc, particularly 100 to 500 cc, especially 200 to 400 cc, and such a frequency distribution of fiber length as comprises 50 to 95%, particularly 60 to 95%, especially 70 to 95%, based on the total fiber, of fibers whose length ranges from 0.4 mm to 1.4 mm (range A). Using such a pulp slurry brings about improved transfer of the inner configuration of the cavity.

On the other hand, it is preferred for the pulp slurry to be used for forming the second pulp layer 57 as the innermost layer to contain pulp fibers having an average length of 0.8 to 2.0 mm, particularly 0.9 to 1.8 mm, especially 1.0 to 1.5 mm, a Canadian Standard Freeness of 100 to 600 cc, particularly 200 to 500 cc, especially 300 to 400 cc, and such a frequency distribution of fiber length as comprises 20 to 90%, particularly 30 to 80%, especially 35 to 65%, based on the total fiber, of fibers whose length ranges from 0.4 mm to 1.4 mm (range A) and 5 to 50%, particularly 7.5 to 40%, especially 10 to 35%, based on the total fiber, of fibers whose length is more than 1.4 mm and not more than 3.0 mm (range B) as shown in Fig. 4. Use of such a pulp slurry effectively prevents development of cracks and thickness unevenness during papermaking. It is particularly preferred for enhancement of the above effects that the frequency distribution curve has a peak in each of ranges A and B. Where such a pulp slurry is used, the thickness of the innermost layer is preferably 30 to 95%, still preferably 50 to 90%, of the total thickness.

Where it is desired to obtain a certain characteristic by addition of a specific additive or pulp fiber, this can be achieved in the present embodiment by adding the additive, etc. only to a specific layer where the desired characteristic is to be manifested most efficiently. This is advantageous in that the amount of the additive, etc. can be reduced as compared

with the production of a monolayer pulp molded article.

According to the present embodiment, it is possible to produce a pulp molded article having more layers than the layer structure shown in Fig. 18. For example, as shown in Fig. 19, a third pulp layer 59 different in composition from both the second pulp layer 57 and the first pulp layer 55 is formed on the side of the second pulp layer 57 shown in Fig. 18, and a mixed layer 58 whose composition continuously changes from the composition of the second pulp layer 57 to that of the third pulp layer 59 is formed between the second pulp layer 57 and the third pulp layer 59, making five layers in all. In this case, a multilayered molded article made up of a plurality of materials is obtained. In another case, another first pulp layer 55' is formed on the side of the second pulp layer 57 shown in Fig. 18, and a mixed layer 56' whose composition continuously changes from the composition of the second pulp layer 57 to that of the first pulp layer 55' is formed between the second pulp layer 57 and the first pulp layer 55', making five layers in all in which the innermost layer and the outermost layer have the same composition. In this case, by making the first pulp layers 55 and 55' of pulp having high whiteness and making the second pulp layer ~~56~~ 57 of pulp having such whiteness as of used paper, a molded article which has an appearance of high whiteness and yet is competitive in price can be obtained.

The present invention is not limited to the above-described embodiments so that the steps, apparatus, members and the like in each of the above-described embodiments are interchangeable with each other. The molds that can be used in the present invention may be composed of a set of two or three or more papermaking splits in accordance with the shape of articles to be molded. The same applies to the heating molds.

Examples:

The present invention will now be illustrated in greater detail, but the scope of the present invention is not construed as being limited thereto.

EXAMPLES 1 TO 5

Bottles shown in Fig. 1 were molded by the method shown in Fig. 5. The particulars of the pulp in the slurry used are shown in Table 2 below. Molding properties in the molding

are also shown in the Table. In Table 2, "used paper B" used in Examples 2 to 4 is used paper used in OA equipment which comprises LBKP and has a small freeness, while the LBKP used in Example 5 is CENIBRA (trade name), which has a large freeness. The resulting molded articles had no seams in their body portion and smooth outer and inner surfaces.

TABLE 2

Ex. No.	Raw Material	Avg. Fiber Length (mm)	Freeness (cc)	Fiber Length Frequency Distribution		Molding Properties
				Range A	Range B	
1	used paper A	1.50	390	43.4	28.5	good
2	NBKP/used paper B*1 =70/30*2	1.29	350	57.5	22.0	good
3	used paper A/used paper B*3 =50/50*2	0.92	350	73.4	9.2	good
4	used paper A/used paper B*3 =30/70*2	0.87	450	77.4	7.6	good
5	used paper A/LBKP*4 =50/50*2	0.92	450	79.7	8.0	good

*1: Average fiber length of NBKP: 2.29 mm; average fiber length of used paper B: 0.82 mm
*2: Weight ratio
*3: Average fiber length of used paper A: 1.5 mm; average fiber length of used paper B: 0.82 mm
*4: Average fiber length of used paper A: 1.5 mm; average fiber length of LBKP: 0.81 mm

As is apparently seen from the results in Table 2, the molded articles of Examples 1 to 5 prepared from a slurry containing pulp having a specific average fiber length, a specific freeness, and a specific fiber length frequency distribution show satisfactory molding properties. While not shown in the Table, the molded articles of Examples 2, 3 and 5 made of a blend comprising long pulp fibers and short pulp fibers and containing a large proportion of pulp fibers in range A had particularly excellent surface smoothness.

EXAMPLE 6

A molded article shown in Fig. 10 was obtained by the method shown in Fig. 5. The molded article had an Ra of 3 μm and an Rmax of 30 μm. The corners linking each side wall and the corners linking each side wall and the bottom had a radius of curvature of

10 mm. There was no seams in the body portion, and the outer and the inner surfaces were smooth. The molded article was set in the vacuum chamber shown in Fig. 13 and laminated with a plastic film by the aforementioned method. Laminating was performed with sufficient adhesion. The plastic film used was a laminate film composed of an ionomer resin (glass transition point: −110°C) and an EVA resin (glass transition point: −75°C) (film thickness: the former/the latter =100 μm/50 μm). In laminating, the plastic film was heated to 100°C in a non-contact state. The thickness of the plastic film as laminated was about 40 μm. The plastic film-laminated molded article was heated up to 120°C while applying pressure and gradually cooled to a room temperature. After allowing the thus treated molded article to stand at 60°C for 30 minutes, the shrinkage percentage of the plastic film in the lateral direction was measured, which was found to be 3.2%.

Separately, laminating was carried out in the same manner as described above on the same molded article except for having a radius of curvature of 2 mm at the above-described corners. Compared with the above-described example, the adhesion was slightly reduced, but the laminating was accomplished with such adhesion as to withstand practical use.

EXAMPLES 7 TO 10

A slurry for outermost layer containing 1.0% by weight of pulp fiber whose physical properties are shown in Table 3 was injected into the cavity of the mold shown in Fig. 17 through the pulp slurry inlet gate under a pressure of 0.3 MPa. The cavity was dewatered to form an outermost layer of the slurry for outermost layer on the inner wall of the cavity. Concurrently with the formation of the outermost layer, a slurry for innermost layer containing 1.0% of pulp fiber whose physical properties are shown in Table 3 was injected into the cavity under a pressure of 0.3 MPa. Air was introduced into the cavity through the pulp slurry inlet gate under a pressure of 0.1 MPa to form, on the outermost layer, a mixed layer whose composition continuously changed from that of the slurry for outermost layer to that of the slurry for innermost layer and, on the mixed layer, an innermost layer was further formed of the slurry for innermost layer. A pressing member comprising an elastic member was inserted into the thus obtained pulp deposited body, and air was fed into the pressing member under a pressure of 1.5 MPa to press the pulp deposited body onto the inner wall of the cavity for dewatering.

The mold was opened to take out the pulp deposited body, which was then set in a heating mold having the same cavity configuration as the shaping mold. A pressing member comprising an elastic member was inserted into the pulp deposited body set in the heating mold. Air was introduced into the pressing member under a pressure of 1.5 MPa to press the pulp deposited body onto the inner wall of the cavity while heating the heating mold at 200°C to dry the pulp deposited body. After the pulp deposited body dried sufficiently, the heating mold was opened to take out the molded bottle. The molding properties of the resulting molded article are shown in Table 3. The surface roughness of the molded article was measured with Surfcom 120A available from Tokyo Seimitsu K.K. The transfer properties of the inner cavity configuration to the molded article were evaluated with the naked eye. A 20 mm wide by 70 mm long piece was cut out of the resulting molded article. The cut piece was partly separated along the mixed layer to prepare a Y-shaped specimen. The specimen was set on a tensile tester with a chuck distance of 20 mm and peeled at an angle of 180° and a pulling speed of 30 mm/min. The results of the peel test are shown in Table 3.

EXAMPLE 11

A bottle was molded in the same manner as in Example 9, except that the slurry for outermost layer was injected into the cavity to complete formation of the outermost layer, and then the slurry for innermost layer was injected into the cavity to form an innermost layer on the outermost layer. The resulting molded article had no mixed layer between the outermost layer and the innermost layer. The same measurements as described above were made on the resulting molded article. The results obtained are shown in Table 3.

TABLE 3

Ex. No.	Pulp Fiber of Slurry for Innermost Layer				Pulp Fiber of Slurry for Outermost Layer			Thickness (μm)			Evaluation			
	Avg. Fiber Length (mm)	Free-ness (cc)	Fiber Length Frequency Distribution (%)		Avg. Fiber Length (mm)	Free-ness (cc)	Fiber Length Frequency Distribution (%): Range A	Inner-most Layer	Mixed Layer	Outer-most Layer	Mold-ing Prop-erties	Surface Rough-ness Ra (μm)	Transfer Prop-erties*	Layer Sepa-ration
			Range A	Range B										
7	1.50	310	43.4	28.5	0.64	280	72.8	300	100	100	good	2-3	A	not observed
8	1.50	310	43.4	28.5	0.64	280	72.8	200	100	200	good	2-3	A	not observed
9	1.50	310	43.4	28.5	0.48	100	56.3	300	100	100	good	1-2	A	not observed
10	1.50	310	43.4	28.5	0.93	400	73.0	300	100	100	good	3-5	B	not observed
11	1.50	310	43.4	28.5	0.64	280	72.8	350	0	150	good	2-3	A	slightly observed

* A: Neither cracking nor fluffing was observed.

B: No cracks developed, but fluffing was observed.

It is apparently seen from the results shown in Table 3 that the molded articles of Examples, in which the innermost and the outermost layers are formed by using slurries containing pulp fiber having specific physical properties, are prevented from developing cracks or unevenness of thickness (development of a part whose thickness is half or less the average thickness or a part with such a reduced thickness as can be perceived by the eye when held up to the light) and have excellent surface smoothness. The molded articles of Examples each had no seams on their body portion, and their outer and inner sides had a smooth surface. In particular, the molded articles of Examples 7 to 10 which had a mixed layer between the innermost layer and the outermost layer had an increased peel strength between the innermost layer and the outermost layer as compared with the molded article of Example 11.

Industrial Applicability:

As is apparent from the foregoing description, the present invention provides a pulp molded article having high strength, excellent productivity, and excellent appearance. The molded article can be produced at a low cost. Besides, it can be recycled or incinerated after use, which leads to reduction of waste.